SCIENCE

VOL. 94 FRIDAY, NOVEMBER 7, 1941 No. 2445

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

FUTURE SOURCES OF POWER[1]

By Professor C. C. FURNAS

YALE UNIVERSITY

THE sun's rays shower as much energy on the earth's surface in one minute as the entire human race utilizes in one year. Despite the presence of this bountiful and unusual flow of energy, a large part of the struggles of the human race are concerned with acquiring and controlling sources of power. Evidently our state of development in the utilization of power is still rather crude. A review of the various practical sources of the present day is in order.

PETROLEUM

The energy supply which is most critical in America is that of petroleum. At the present time we are using considerably over a billion barrels per year. The known proved reserve of petroleum in the ground is 14 to 17 billion barrels, depending on who does the estimating. Thus the petroleum actually in sight is only about a twelve-year supply. But new discoveries are being made constantly so most of the people in the petroleum industry say they are not worried about the supply, at least for the present generation. It is a little discouraging to note, however, that the new discoveries are not quite keeping pace with use so the pinch of partial depletion may come sooner than the optimists anticipate.

There may be discoveries of great new fields, but the prospects of that are not very good. There is the possibility of extensive fields lying under the ocean

[1] Summary of an address before a joint meeting of the Rochester, Syracuse and Cornell sections of the American Chemical Society, Rochester, N. Y., October 4, 1941.

next to coastal plains such as border the Gulf of Mexico. There may also be a great deal of petroleum at far greater depths than are yet explored. We live in hopes that there are, but it should be remembered that if recovery is made from the more difficult places, the cost of production is certain to rise and the customer must pay for it.

Technical advances in refining have greatly extended the potential life of the petroleum resources. The wide-spread utilization of cracking has more than doubled the yield of gasoline and hence has more than doubled the potential supply of motor fuel. Now the polymerization of refinery gases into liquid fuels is beginning to come in and is helping to extend the life line of petroleum. Such technical advances are a great factor in keeping up the liquid fuel supply, but eventually, perhaps distressingly soon, the pinch of depletion will begin to make itself felt. What then? There are several possibilities that need to be evaluated.

I. *Getting all the petroleum out of the ground.* Even with the best production methods, over half the original petroleum deposit still stays in the ground after the well has gone dry. Mining of the sands seems to be impractical, not to mention being very expensive. If some one will devise an inexpensive means of breaking the adsorptive forces between petroleum layers and the sand grains, he will greatly lengthen the life of our oil resources, not to mention the possibility of making himself rich.

II. *Shale oil.* There are many billions of tons of oil shale in this country which when heated will yield from half a barrel to two or three barrels of petroleum-like oil per ton of shale. The potential supply is enough to supply our motor fuel for from 100 to several hundred years, depending on the grade of shale considered acceptable. But mining or quarrying the shale, retorting it and disposing of the waste costs effort and money. If the refinery cost of gasoline should double above its present figure of 5 to 6 cents per gallon then shale oil might begin to compete. Thus we have a considerable back log of motor fuel, but we will only get it by paying higher prices than at present.

III. *Hydrogenation of Coal.* Germany and, to a certain extent, England are making fairly satisfactory liquid fuels by reacting hydrogen gas with low-grade coal at high temperature and pressure in the presence of a catalyst. But the cost of production is about 20 cents a gallon compared to the American cost of 5 to 6 cents a gallon from petroleum. That high cost might be lowered somewhat, but the prospects are that it will not go down materially. Thus we can drive our cars on motor fuel from coal, but we'll have to pay dearly for it.

IV. *Alcohols from Agricultural products.* This is great fuel for politicians from the corn belt but not so practical for automobiles. The first item is cost—15 to 20 cents a gallon under best practice; next, lack of supply—a small fraction of our fuel might be supplied from waste and surplus farm products, but it would require nearly all the good crop land in the country to supply our motor fuel demand by this means. There wouldn't be anything left to eat.

Summarizing liquid fuels: We can have fuel for automobiles for at least several generations but at a price. The lush days of practically free oil from the ground will begin to end some of these days—probably too soon to please us. This generation may very well feel the pinch of partial depletion. Any economy or conservation steps are very much in order.

V. *Duplication of Geochemical Reactions.* Dr. Ernst Berl at the Carnegie Institute of Technology has succeeded in making liquid and solid fuels which are close duplicates of our petroleum and coal, using natural carbohydrates such as sugar as the starting material. He has apparently duplicated and greatly accelerated the geochemical reactions which produced these fuels. If we are to supply part of our fuel demands from current vegetation, Dr. Berl's work may be the best starting point.

Coal

In coal we are the most happily situated country in the world. We have over half of the world's known coal reserves; less than 6 per cent. of the world's population. At the present time we have enough coal in sight (all grades) to last 3,000 years. That picture may change if the other 94 per cent. of the people of the world decide that we must divide up, but that is one of the unpredictables. Hence as regards coal we may say that we are very lucky. But that doesn't mean we should be negligent of conservation. Within the next hundred years many of the best deposits will be depleted. We will have to begin depending on the lower grades. Expenses of recovery will go up, quality will go down. It will be wise to extend the life of our A-1 deposits as long as possible.

Eventually, no matter how much we conserve, this sponging off past ages for fossil energy must cease—the deposits will have gone up in smoke. What then? That's a question which America will face eventually, which many groups of people in the world are facing right now. Other possible sources of energy certainly should be considered.

Other Sources of Power

I. *Water power.* The water power sources of the world are by no means fully developed, but even if they were they would be quite inadequate. About 10

per cent. of America's energy comes from water power. By full development that could be extended to 20 or 25 per cent. It helps, but it simply is not enough.

II. *Wind.* Lots of energy goes to waste in a hurricane or tornado, but you can't count on it. The winds are not dependable even in Kansas. Moreover, the average breeze is at a very low potential as far as energy is concerned. Except for isolated, special cases where a high-cost storage capacity can be provided, wind power seems to be out.

III. *Tides.* In a limited number of places, such as ill-famed Passamaquoddy Bay, the use of tidal power may be practicable if a possible market is close at hand. Like the power from falling water, this may help, but it can supply only a small proportion.

IV. *Wave power.* Many wave motors have been designed; some of them have been patented. But the item of variability of the source of power seems to relegate this device to the impractical heap.

V. *Utilization of current vegetation.* About fifty times as much energy is stored up in plant life on the earth in one year as man utilizes in that year. It might then appear that we could use the present growing trees, grasses and shrubs for fuel and then solve the problem. Close investigation makes that idea discouraging. In the United States we would have to use nearly all our annual crop of vegetation (trees, grass, farm crops) to meet the energy demand. Nothing would be left to eat, and the land would all be a desert in a few years. We can't push vegetation very far from its natural cycle. All the data shows that we can not go back to a tree- and brush-burning economy.

VI. *Atomic energy.* The business of smashing atoms to release great gusts of energy is a profitable sport—for news reporters. Radioactive materials, of which there are only minute amounts in the earth, disintegrate and slowly release large amounts of energy. If radium, for instance, were as plentiful as copper, atomic boilers using radium as fuel might be practical, but there just isn't very much radium available. Recent work has shown that one of the isotopes of uranium, U_{235}, upon bombardment with slow neutrons, will disintegrate to give a net yield of energy equivalent to the burning of 3,000,000 times the same weight of coal. But separation of this isotope, U_{235}, has not yet been accomplished except in sub-microscopic quantities. Any other materials tried have not thus far shown any hopes for energy production. Thus any Atomic Energy Development Company seems to be facing a stone wall of discouraging facts. One can not arbitrarily say that we will never be able to get energy from atomic disintegration, but in our present forecasting we will be on safer ground if we don't count on it.

Direct Utilization of Solar Radiation

This brief survey has not answered the question of where we will get our energy, but it has pretty well covered the possible sources—excepting one—the direct utilization of the energy of the sun's rays.

The average intensity of solar energy in this latitude amounts to about 0.1 of a horse power per square foot. The energy falling on one square yard of roof would more than operate all the electrical household appliances, including lights, of the average family—if it could be directly utilized. Most factories have energy falling on the roof to operate all the machinery in the place—if the management had enough ingenuity to utilize it. No one has developed that ingenuity yet.

Photoelectric Cells. One of the obvious possibilities for direct utilization of solar energy lies in photoelectric cells. Thus far photoelectric cells have operated with microscopic efficiency and have been very expensive. If some one can make revolutionary improvements in photoelectric cell efficiency and can cut the cost of construction away down we might have something there. At present the prospects are discouraging, but one hesitates to say such utilization is forever impossible. Even with the items of efficiency and cost brought under control, the matter of storage of energy during periods of darkness would be troublesome. Large storage reservoirs of water might solve this problem, pumping water to high levels in daylight hours, using it in water turbines during darkness. The overall efficiency of such storage can be about 70 per cent. In general, it may be said that photoelectric cells are barely possible but not hopeful.

Solar Boilers. The simple and obvious device of using focussed sun's rays to heat up a liquid has been toyed with for a long time. Solar-boilers of various degrees of impracticality have been the child of many inventors' minds and the subject of many patents. Dr. Abbot, of the Smithsonian Institution, has a small solar power plant with revolving parabolic mirrors for which he claims an electrical energy production efficiency of 15 per cent. We'll have to do better than that if the sun's rays, which are not at very high intensity to begin with, are to be a practical source. It is not likely that the efficiency of the solar power plant, if it operates by steam generation, can be greatly improved.

On the other hand, solar energy may very well be on the verge of being practical for heating of buildings where a high potential is not important. The storage capacity must be sufficient for weeks or even months of operation. A basement full of hot water, periodically reheated by sun's rays, might be possible, but it hardly sounds practical. I would think that a closed cycle of employing a low-boiling liquid might better serve for such storage. First costs would be

high, but operating costs might be cut to the vanishing point.

Such an idea may bring a smile, but it is now becoming almost respectable, for the Massachusetts Institute of Technology has begun some experimentation along this line.

Photochemical Reactions. The foregoing suggest some interesting ideas, but with the exception of heating buildings, they do not seem to come within a gunshot of practicality. I have saved what I consider to be the best idea until the last. Namely, men should try to do efficiently what nature has been doing inefficiently for a billion years—utilize photochemical reactions. The basis of all life is some simple photochemical reaction as

$$H_2O + CO_2 + \text{Radiant Energy} = \underset{\text{Formaldehyde}}{HCHO} + O_2$$

The formaldehyde may be thought of as forming simple sugars, which then serve as the basic material for the multitude of complex compounds in plants. I realize that the actual photochemical reaction is much more complicated than this and that the formaldehyde theory is no longer tenable, but I am using this as the simplest picture to illustrate the point. What we should like to do would be to take some such simple compound as formaldehyde formed with the help of radiant energy, put it in an electrochemical cell, expose it to oxygen, and then reverse the above reaction and get back the stored energy as electrical energy—at high efficiency. Formaldehyde *can* be oxidized in a cell in a basic solution to give formic acid and a small amount of electrical energy. Perhaps all that is needed is a proper catalyst to complete the oxidation to CO_2 and water and get back nearly all the stored energy.

The catalyst which nature used for performing the photosynthesis of the above equation is chlorophyll. That's the best catalyst known, but it's very poor. Plants are very inefficient storers of energy. Even the most luxuriant plants have an energy storage efficiency of less than 2 per cent. We ought to be able to do a lot better than that.

It's a wide-open field, this study of photosynthesis and the study of oxidation cells which will reverse the reaction. That's the reason it's hopeful. The systems which might be used would not have to be limited to organic compounds. It may well be that inorganic compounds offer the most hope. The satisfactory system would need to be one that is as light-sensitive as the chemicals on a photographic film, as easily reversible as a lead storage cell. If such a photochemical-electrical system can be developed the problem of energy capture and storage would be solved. The storage of the energy would be simply that of storing chemical compounds. We're used to doing that with coal.

Conclusion

Some day the photochemical approach to energy utilization will either be solved or definitely proved impracticable. In view of our own energy resources it may seem foolish to start working on it now. But it may not be too early to start. If we wait too long we may be caught short as energy supplies dwindle. Moreover, many parts of the world already suffer from insufficient energy. Many international problems might disappear if every group of people could fully utilize the energy falling on its roof-tops.

Enough energy falls on about 200 square miles of an arid region like the Mohave Desert to supply the United States. When we become ingenious enough to efficiently utilize the energy treasure wherever it may fall, we may solve many of our economic problems. It might be a little hard on the railroads that haul coal, but every one else would benefit.

A PRACTICAL SYSTEM OF UNITS FOR THE DESCRIPTION OF THE HEAT EXCHANGE OF MAN WITH HIS ENVIRONMENT

By Drs. A. P. GAGGE, Yale University; A. C. BURTON, University of Toronto, and H. C. BAZETT, University of Pennsylvania

THERE are three groups interested in the thermal exchanges of the human body, namely, the heating engineers, the physicians and the physiologists. In the English-speaking countries each of these groups by training uses a different set of physical units. The heating engineer uses B.T.U., square feet and °F., the physician calories, square meters and °F., and the physiologist calories, square meters and °C. Consequently they find it difficult to make themselves mutually understandable when discussing their common interest of heat exchange. It is our proposal to present a system of units such that all three groups may think in terms of a common and at the same time a practical system.

Thermal comfort in any environment is dependent on many variables. There is evidence that in the final analysis comfort is dependent largely upon skin temperature. The optimal average skin temperature for

comfort appears to be 92° F (33° C). Such an average skin temperature may be maintained in spite of exposure to cold if the clothing is properly chosen in relation to activity. Temperature regulation can be attained under less favorable conditions by adjustments of the skin circulation and evaporation of water when skin temperature may have higher or lower levels. Optimal comfort, however, is not achieved in the presence of such adjustments.

If thermal equilibrium is to be attained without the necessity of these physiological adjustments, it is obvious that the three factors concerned for a balance at an assumed optimal skin temperature are the rate of heat production of the body (dependent on the degree of muscular activity), the insulating value of the clothing and the environmental temperature. Consequently, the use of practical units for thermal activity and for insulation would provide a uniform system to describe comfortable conditions in relation to the heat exchange of man with his environment.

The proposed thermal activity unit may be defined as 50 calories per hour per square meter of the surface area of the individual (or 18.5 B.T.U./Hr./Sq.Ft.). This is approximately the metabolism of a subject resting in a sitting position under conditions of thermal comfort. This unit may be called 1 *met*, and may be utilized by any of the groups, regardless of the other system of units employed.

The unit for thermal insulation of clothing is logically the amount of insulation necessary to maintain in comfort such a sitting-resting subject in a normally ventilated room (air movement 20 ft/min or 10 cm/sec) at a temperature of 70° F (21° C) and a humidity of the air which is less than 50 per cent. This unit of insulation may be called 1 *clo*. Since, in the conditions outlined above, thermal equilibrium is maintained, the insulating value of 1 clo can be expressed and defined in terms of the common system of units.

Thermal insulation is the resistance offered to flow of heat, just as electrical insulation is related to flow of electricity. It is measured by the ratio of the difference in temperature between two surfaces, to the flow of heat per unit area that results. Thermal insulations thus estimated and expressed in clo units, may be treated mathematically just as are the comparable electrical resistances expressed in ohms. For men in the conditions already specified, it may be assumed that 24 per cent. of the resting metabolic heat is dissipated by evaporation of insensible perspiration. The remaining heat transmitted through the clothing is, therefore, 38 (76 per cent. of 50) Cals./Hr./Sq.M. The difference in temperature concerned is 33°–21° C. Then the total insulation, which is the sum of the insulation of the clothing, I_{Cl}, and that of the ambient air, I_A, is given in metric units by the equation

$$I_{Cl} + I_A = \frac{33 - 21}{38} = 0.32 \frac{°C.}{Cals./Hr./Sq.\ M.}.$$

From previous work[1] at the John B. Pierce Laboratory, the insulation of the air in metric units at the air movement cited is

$$0.14 \frac{°C.}{Cals./Hr./Sq.\ M.}.$$

Consequently, the insulation of the clothing, which is equal by definition to 1 clo, is

$$0.32 - 0.14 = 0.18 \frac{°C.}{Cals./Hr./Sq.\ M.}.$$

The clo unit is therefore defined as

$$0.18 \frac{°C.}{Cals./Hr./Sq.\ M.} \text{ or } 0.88 \frac{°F.}{B.T.U./Hr./Sq.\ Ft.}.$$

In general, the relation between the insulation of the clothing, I_{Cl}, that of the ambient air, I_A, the heat production, M, the evaporated loss, E, and the temperature of the air, T_A, for optimal comfort expressed in Met and Clo units is

$$I_{Cl} + I_A = \frac{33° - T_A}{9.0\ (M–E)}, \text{ for °C.,}$$

or

$$= \frac{92° - T_A}{16.2\ (M–E)}, \text{ for °F.}$$

These equations hold only for muscular activity when no external work is accomplished. When the latter is the case the work performed, W, must also be subtracted in the denominator from the total heat production, M.

The value of I_A varies with the surrounding air movement, whether this be produced by wind or the activity of the subject. The variations in I_A so produced are indicated in Table I. Since the heat loss is determined by the total insulation, it is obvious that the effect of variations in I_A produced by air movement is less important, the heavier the clothing. It may also be seen that the total insulation of the air plus normal clothing is reduced 33 per cent. if the subject changes from sitting indoors to sitting out-of-doors on a windy day. On the other hand, if the subject is doing level walking the reduction is only 12 per cent.

TABLE I

VARIATIONS IN INSULATION OF AMBIENT AIR IN CLO UNITS

Air movement	Resting sitting	Level walking		
		Slow	Normal	Fast
Normal indoors (20 F.P.M.)	.78	.37	.33	.29
Drafty indoors (100 F.P.M.)	.40	.32	.29	.26
Normal outdoors (5 M.P.H.)	.30	.24	.22	.20
Windy outdoors (20 M.P.H.)	.19	.18	.17	.16

It is now possible to predict what are the optimal temperatures for persons wearing normal clothing (1

[1] Winslow, Gagge and Herrington, *Am. Jour. Physiol.*, 131: 79, 1940.

clo) engaged in the following degrees of exercise. It is assumed, for purposes of analysis, that 24 per cent. of the total energy production is lost by evaporation, and that, as before, the optimal skin temperature for comfort in exercise is 92° (33° C). Neither of these assumptions are likely to be precisely true. The optimal temperatures are given in Table II.

TABLE II

OPTIMAL TEMPERATURES FOR COMFORT WITH EXERCISE IN NORMAL CLOTHING

Place	Resting sitting M = 1	Slow level walking M = 2	Normal level walking M = 3	Fast level walking M = 4
Normal indoors.	70.0° F	58.4° F	43.0° F	28.5° F
Drafty indoors..	74.8°	59.6°	45.6°	30.0°
Normal outdoors	76.0°	61.5°	47.0°	33.0°
Windy outdoors	77.6°	63.2°	48.8°	35.0°

It may be deduced from Table II that if the external temperature is much above that indicated, normal equilibrium can only be attained by increasing the evaporative heat loss through sweating. The amount of such increase can be approximately estimated. For instance, if an individual is walking fast indoors (producing 4 mets) at a temperature of 58.4° F, at which only 2 mets can be dissipated with comfort, the additional 2 mets must be lost by evaporation. (For more precise predictions, the changes in insulation of the ambient air with activity would have to be considered.)

Also the ideal amount of clothing, in clos, necessary for comfort for various degrees of rest and exercise in different outdoor environmental temperatures may be predicted as shown in Table III.

The net efficiency of the human body in performing external work does not exceed 20 per cent., *i.e.*, in doing ½ met of external work the extra heat production will be at least 2½ mets, and the total will rise to at least 3½ mets. In many cases the efficiency is far less, as in level walking where the heat production rises to

TABLE III

IDEAL CLOTHING FOR COMFORT

Environmental temperature	Resting sitting	Slow level walking	Normal level walking	Fast level walking
70° F—Normal outdoors	1.5	.7	.4	.3
50° F— " "	3.1	1.5	.9	.7
30° F— " "	4.7	2.3	1.5	1.1
0° F— " "	7.2	3.5	2.3	1.7

several mets without the accomplishment of any external work. Using the figure of 20 per cent., the maximum clothing that could be worn in comfort in a given task may be calculated. For example, a mountaineer weighing 160 pounds, surface area 1.9 square meters, climbing at the rate of 1,250 feet per hour, would accomplish a mean rate of work of 0.75 mets. The minimal total metabolism would be 4.75 mets, and the heat to be lost 4.0 mets. Since fast level walking has been assumed as equivalent to 4 mets, it may be seen from Table III that at an external temperature of 30° F without wind, the maximal clothing he could wear for comfort would be about 1 clo.

The advantage of using the practical units, *met* and *clo*, instead of the classical metric and British units is that they describe energy and insulation values in terms of familiar concepts. One *clo* approximately is the value of the insulation of one's everyday clothing (and incidentally of a heavy top coat alone). The additional insulation conferred by top coats, etc., may be expressed in these units. One met unit varies in absolute amount with the size of the individual. For a man of average size it is approximately equivalent to the heat generated by a 100-watt lamp. Thus, speaking in units associated with one's normal experience, the engineers, the physicians and the physiologists should be able to use their individual training more effectively in a common effort to solve current problems of heating and ventilation, as well as those of the physiological adjustments associated with the maintenance of heat balance.

OBITUARY

FRANK BURR MALLORY

DR. FRANK BURR MALLORY died at his home in Brookline, Mass., on September 27, at the age of 78. Dr. Mallory was born in Cleveland, Ohio, on November 12, 1862. He graduated from Harvard College in 1886 with the degree of A.B. He received his A.M. and M.D. from Harvard Medical School in 1890. He became associated with Harvard Medical School in 1890, first as assistant in histology, later as assistant in pathology. He was appointed assistant professor of pathology in 1896, associate professor in 1901 and professor in 1928. He retired with the title of emeritus professor in 1932. He joined the pathological staff of the Boston City Hospital in 1891 and was made pathologist in 1908. In 1932, at the age of 70, he retired, becoming consulting pathologist.

Dr. Mallory received the honorary degree of Sc.D. from Tufts College in 1928 and from Boston University in 1932. He was awarded the Kober medal in 1935 by the Association of American Physicians for outstanding service in pathology. In the same year he received the gold-headed cane from the American Association of Pathologists and Bacteriologists. This cane was presented to the association by Dr. Harold

C. Ernst to be awarded for special merit. The previous recipients of this honor were Dr. William H. Welch and Dr. Theobald Smith.

Dr. Mallory served as treasurer of the American Association of Pathologists and Bacteriologists from 1911 to 1940. He also was a past president of this organization. In 1923 he became editor-in-chief of the *Journal of Medical Research* and in 1925, when that journal became the *American Journal of Pathology*, he continued to serve in the same capacity until 1940. Dr. Mallory was a member of numerous American scientific societies. He was also a corresponding member of the Royal Medical Society of Budapest, a member of the Deutsche Pathologische Gesellschaft and an honorary member of the Pathological Society of Great Britain and Ireland.

In 1897, he published, with Dr. J. Homer Wright, "Pathological Technique." This went through eight editions, a final revision appearing in 1938. Dr. Mallory's "Principles of Pathologic Histology" was published in 1914.

Among Dr. Mallory's numerous contributions to the literature may be mentioned his studies on the classifications of tumors, technical methods, cirrhosis of the liver and infectious diseases. He early evinced a keen interest in staining methods and his third paper, published in 1895, while working with Ziegler in Freiburg, was the first of a long series of papers dealing with technical methods. In addition to developing new stains, he always stressed the importance of precision in histopathological procedures and insisted on the maintenance of high standards in his laboratory. Through the use of his methods, he contributed much of prime importance to the classification of tumors based on morphological characteristics. He was an exceedingly keen observer and his diagnostic ability was such that he was regarded by many as the court of last appeal in difficult or unusual cases.

Dr. Mallory's earlier papers were illustrated by drawings, but in 1901 he began using microphotographs. He was greatly interested in this branch of photography and developed it to a high degree of perfection. He was extremely critical of his own work and would discard everything that did not satisfy his ideals. As an editor he also demanded from contributors that their illustrations be of high quality. As a result the journals he edited were noted for the excellence of their illustrations.

In the fiftieth anniversary year book of his college class, he wrote, "I can say that I have been able to work all my life at just what I wanted to, to make a modest but sufficient income for a comfortable living and to take a lot of pleasure out of my existence." That statement well expressed his attitude towards his work. He was devoted to his laboratory and everything connected with it. He was endowed with a divine enthusiasm which was unaffected by age or infirmity. After his retirement as pathologist in 1932, he continued to come to the laboratory just as regularly as before. He was one of the first to arrive in the morning and always came in on Sunday mornings. He was actively engaged in experimental work up to the time last February when he was compelled by his physical condition to leave the laboratory.

One of his great services to medicine was the training of young men in pathology. The number of graduates who were trained under him was approximately 125. Many of them are preeminent not only in pathology but also in clinical medicine as well. He took a great interest in the members of his staff, and their contact with him was close. He strove ceaselessly to instill in them his high ideals and to imbue them with his intense interest in pathology in all its various aspects. As a result of their service under him, his graduates received a thorough grounding both in morphology and in the application of technical procedures. There was always a demand for Mallory-trained men throughout the country both by medical schools and by hospitals.

Dr. Mallory was very fond of the outdoors. He early developed an interest in botany which he maintained throughout his life. He was a tennis enthusiast and played up until a few years ago. In this game, as in his laboratory life, he insisted upon the importance of proper technic. When he witnessed a match between experts, he was as much, if not more, interested in the form of the contestants as in the match itself. Canoeing also was a favorite pastime with him, and for many years he spent Saturday afternoons on the Charles River. Throughout his life, he was a great walker and when increasing age interfered with his other activities, he continued this form of exercise up until a few months of his death.

The death of Dr. Mallory has meant not only a great loss to scientific medicine but an equally great loss to all those who were fortunate enough to know him as a man.

F. PARKER, JR.

BOSTON CITY HOSPITAL

RECENT DEATHS

DR. ERNEST EVERETT JUST, for twenty-six years head of the department of zoology at Howard University, a member of the faculty for thirty-four years, died on October 27 at the age of fifty-eight years.

JOSEPH S. STANLEY-BROWN, from 1892 to 1932 editor of the *Proceedings* of the American Geological Society, died on November 2 at the age of eighty-three years.

SCIENTIFIC EVENTS

THE PERMANENT SCIENCE FUND OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES

INCOME from the Permanent Science Fund, according to agreement and declaration of trust, shall be applied by the American Academy of Arts and Sciences to such scientific research as shall be selected ". . . in such sciences as mathematics, physics, chemistry, astronomy, geology and geography, zoology, botany, anthropology, psychology, sociology and economics, history and philology, engineering, medicine and surgery, agriculture, manufacturing and commerce, education and any other science of any nature or description, whether or not now known or now recognized as scientific, and may be applied to or through public or private associations, societies, or institutions, whether incorporated or not, or through one or more individuals."

Applications for grants under this indenture are considered by a committee of this academy on stated dates only. The next meeting to consider applications will be held on February 15, 1942. Applications should be made on special forms furnished by the committee. Correspondence, including requests for application blanks, should be addressed to the chairman of the Committee on the Permanent Science Fund, Professor John W. M. Bunker, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Grants-in-aid, varying from $150 to $600, from this fund have been made to Warren Andrew, assistant professor of histology and embryology, Baylor University; to Forrest F. Cleveland, associate professor of physics, Illinois Institute of Technology; to Rita Guttman, instructor, Brooklyn College; to Rudolf Höber, visiting professor of physiology, University of Pennsylvania; to Lewis H. Kleinholz, instructor, Cambridge Junior College; to Irvin M. Korr, instructor, New York University; to Valy Menkin, assistant professor of pathology, Harvard Medical School; to George H. Parker, professor of zoology, emeritus, Harvard University; to Edward J. Schremp, assistant professor, University of Cincinnati; to Charles W. Turner, professor of dairy husbandry, University of Missouri; to Clarence Zener and Kenneth Fitzsimmons, associate professor and instructor, respectively, State College of Washington.

NEW YORK INSTITUTE FOR HOSPITAL ADMINISTRATORS

A NEW YORK Institute for Hospital Administrators was conducted by the American College of Hospital Administrators at the Cornell University Medical College from October 20 to October 31, inclusive. The institute, the second of its kind, the first having been held in New York in 1939, dealt particularly with the critical problems now confronting hospitals and included conferences on every phase of hospital management. A discussion of the aims of hospital administration was presented by Dr. S. S. Goldwater, president of the Associated Hospital Service of New York, and the problems of hospitals and the government were discussed by Dr. C. W. Munger, director of St. Luke's Hospital. The director of the institute, Dr. Munger, and the secretary, Dr. Jack Masur, executive director of Lebanon Hospital, were in charge of the program.

Hospital administration under wartime conditions was described by Dr. Gerald F. Houser, who has recently returned from the Red Cross-Harvard Hospital, London, and an address on preparing hospitals for war conditions was given by Dr. Albert G. Engelbach, director of the Cambridge Hospital. Other problems relating to hospitals and national defense were covered in a round-table discussion. Field trips were conducted through the New York Hospital-Cornell University Medical College, the offices of the Associated Hospital Service and the department of nutrition of the New York, Presbyterian and St. Luke's Hospitals. Dr. Willard C. Rappleye, commissioner of hospitals of the City of New York, is a member of the executive committee.

Cooperating with the American College of Hospital Administrators in conducting the institute were the faculty of the Cornell University Medical College, the Greater New York Hospital Association, the Hospital Council of Greater New York and hospital associations of the states of New York, Connecticut, Maine, Massachusetts, New Jersey, Pennsylvania and Rhode Island.

The institute was closed with a dinner on October 31, when certificates were presented to those who had participated.

PROCEEDINGS OF THE FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY

THE Federation of American Societies for Experimental Biology will issue in March, 1942, the first number of a quarterly publication to be named the *Federation Proceedings*. This will be published by an editorial board representing the five constituent societies of the federation: The American Physiological Society, The American Society of Biological Chemists, The American Society for Pharmacology and Experimental Therapeutics, The American Society for Experimental Pathology and The American Institute of Nutrition.

Four numbers will be published each year. The

March issue will appear just previous to the annual meeting of the federation, and will be composed of two parts. Part I will include the abstracts of all the papers to be presented at the annual meeting, about a thousand in all. These abstracts will be segregated as to society origin and will be indexed according to subjects and authors. Part II will comprise the program of the scientific sessions of all the constituent societies of the federation. The June and September issues will include the full text of perhaps twenty of the papers presented at the annual meeting as selected by the editorial board, including probably the papers on the joint program of the federation as a whole as well as the papers of one symposium of each of the five societies. The December issue will include material pertinent to the federation membership, which was formerly published in the Federation Yearbook, which will hereafter be discontinued.

In the past each society has printed its own abstracts in advance of the meeting in a separate pamphlet. After the meeting the abstracts were republished in permanent form in the journals of the various societies. In the future a single publication will suffice and abstracts of all the societies will be available in a single volume. Moreover, journal space formerly devoted to abstracts will now be available for the usual scientific papers. The new procedure will be more convenient for reference and will be on the whole more economical. This new publication is certain to be in great demand in libraries because of the large number of short papers which it will contain and to which frequent reference will be made in the literature. In addition, it will make universally available a certain number of the more valuable papers read at the annual meeting which only relatively few persons can hear at the time of actual delivery.

The *Federation Proceedings* will be distributed on payment of dues without further charge to the seventeen hundred members of the federation. The subscription price to non-members will be $4.00 ($4.50 foreign), payable in advance. Single issues may be purchased, if ordered in advance of publication, at prices to be determined at the time of issue. Subscriptions and other communications concerning advertising space, etc., should be addressed to: Dr. D. R. Hooker, Managing Editor, 19 West Chase Street, Baltimore, Maryland.

BOSTON MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA

THE fifty-fourth annual meeting of the Geological Society of America will be held from December 29 to 31 at the Hotel Statler, Boston, under the auspices of the Geological Society of Boston, the Massachusetts Institute of Technology and Harvard University. The address of the retiring president, Dr. Charles P. Berkey, professor emeritus of geology of Columbia University, will be delivered in the Ball Room, on Monday evening, December 29, at 8 o'clock. It will be followed by a smoker.

Associated societies that will hold meetings in conjunction with the Geological Society are:

The Paleontological Society, thirty-third annual meeting, secretary, H. E. Vokes, American Museum of Natural History, New York.

The Mineralogical Society of America, twenty-second annual meeting, secretary, Paul F. Kerr, Columbia University.

The Society of Economic Geologists, twenty-second annual meeting, secretary, W. D. Johnston, Jr., U. S. Geological Survey.

The Society of Vertebrate Paleontology, first annual meeting, secretary, George G. Simpson, American Museum of Natural History, New York.

There will be an all-day tour of Boston Harbor and historic Boston on Tuesday, December 30, and the annual dinner will be held in the ball room of the Hotel Statler at 7 o'clock in the evening. Trips for small groups will be arranged on request. Because of the uncertainty of weather conditions and probable gasoline rationing, no geological trips have been planned. The local geologists, however, will be glad to make tentative plans for informal trips. Any one interested should communicate with Dr. Cornelius S. Hurlbut, Jr., department of mineralogy and petrography, Harvard University, Cambridge, Mass., giving that phase of the local geology in which he is interested. During the meeting fellows of the society are invited to visit the departments of geology at Harvard University and the Massachusetts Institute of Technology.

The Geological Society will join with Section E of the American Association for the Advancement of Science, the Texas Academy of Science and the Association of American Geographers in sponsoring the meetings to be held in Dallas on December 29, 30 and 31. Hugh D. Miser as retiring vice-president will deliver the principal address: "Quartz Veins in the Ouachita Mountains of Arkansas and Oklahoma." The subjects of the three days of meetings are scheduled as follows:

December 29: "Structure and Stratigraphy of the Southwest."

December 30, morning session, jointly with the American Geophysical Union: "Relation of Geology to the Ground-Water Problems of the Southwest."

December 30, afternoon session, jointly with the Section on Anthropology: "Early Man in North America."

December 31: "Regional Geography of the Southwest."

Members of the associated societies are urged to submit their titles and abstracts to their secretary at once to meet the requirements of the Joint Program Committee.

AWARD OF THE WILLIAM H. NICHOLS MEDAL

DR. DUNCAN A. MACINNES, of the Rockefeller Institute for Medical Research, has been awarded the 1942 William H. Nichols Medal of the New York Section of the American Chemical Society in recognition of his "outstanding investigations on electrolytes and the development of techniques which have immeasurably enriched both the theory and practice of modern electrochemistry." His researches have contributed to the development of the glass electrode, widely used in industry. He has also made important investigations in the field of biological chemistry.

According to the statement given out by the jury of award

> For many years Dr. MacInnes has been engaged in fundamental researches on the theory of solutions, and his precise studies have furnished much of the information which we now possess on the behavior of electrolytic solutions. He was one of the pioneers in studying the properties of the glass electrode and in establishing the conditions under which this very useful device may be used for the precise measurement of hydrogen ion concentration.
>
> On the basis of these studies the electrode is now a recognized and dependable device which finds wide industrial use. More recently, Dr. MacInnes and his associates at the institute have turned their interest to the motion of biologically important solutions in an electric field and their experimental investigations in electrophoretic phenomena have greatly increased our knowled of the protein content of the blood serum. These m recent investigations and the successful results are larg based on Dr. MacInnes's earlier studies on simp inorganic systems.

The presentation will be made at a meeting of t New York Section on March 6. Founded in 1902 the late Dr. William H. Nichols, a charter memb of the American Chemical Society and chairman the board of the Allied Chemical and Dye Corpo tion, the medal is awarded annually to "stimulate or inal research in chemistry."

Previous recipients of the award were: John Nelson, Phoebus A. Levene, Joel H. Hildebra Irving Langmuir, James Bryant Conant, Frank Whitmore, William M. Clark, Charles A. Kraus, H S. Taylor, Julius A. Nieuwland, Gilbert N. Le Charles L. Parsons, Claude S. Hudson, Marston Bogert, Henry C. Sherman, Roger Adams, William Noyes, Thomas Midgley, Samuel C. Lind, Leo Baekeland, H. C. P. Weber, Edward C. Frankl M. A. Rosanoff, C. W. Easley, T. B. Johnson, Charl James, M. H. Walker, M. B. Bishop, E. B. Voorhe William L. Evans, Moses Gomberg, Samuel E. Sh pard, John A. Wilson and Dr. Linus Pauling, he of the division of chemistry and chemical engineeri at California Institute of Technology.

Members of the 1942 medal jury in addition Professor MacTavish were Professor Louis P. Ha mett, of Columbia University; Dr. Robert Calve consulting chemist and chemical patent attorney; Pr fessor Ralph H. Muller, of New York Universit chairman of the section, and Dr. Cornelia T. Sne secretary.

SCIENTIFIC NOTES AND NEWS

AT the thirty-second annual dinner of the Radio Club of America on November 1, the fourth award of the Armstrong Medal for "outstanding contributions to the radio art" was made to Harry William Houck. The citation reads: "After assisting at the birth of the superheterodyne in Armstrong's (Major Edwin H. Armstrong, of Columbia University, inventor of the superheterodyne receiver and father of the current FM system) wartime laboratory in Paris he designed the second-harmonic superheterodyne, first type to be placed in large commercial production. Radio receivers operating from alternating current power lines leaned heavily on the technique, designs and inventions of the medalist."

A TESTIMONIAL dinner in honor of Dr. George H. Meeker, dean emeritus of the Graduate School of Medicine of the University of Pennsylvania, was given on September 29, marking his retirement a dean. Dr. George M. Coates was chairman, and D George Morris Piersol, toastmaster. Dr. Thomas S Gates, president, and Dr. Alfred N. Richards, vice president for medical affairs, spoke for the university Dr. William R. Nicholson for the Graduate School and Dr. George E. Pfahler for the Medico-Chirurgical College of Philadelphia, where Dr. Meeker taught before the school was taken over by the university.

DR. GILBERT H. CADY, senior geologist and head of the Coal Division of the Illinois State Geological Survey, was honored at a testimonial dinner in Urbana on the evening of September 27, immediately following the close of the fiftieth anniversary celebration of the University of Chicago, in which Dr. Cady had led the symposium on coal geology. The occasion was in recognition of his thirty-five years of service

in geology, during which he has contributed in a major degree to the training of his students, assistants and associates, many of whom were present at the dinner to do him honor. A portrait of Dr. Cady was presented.

THE honorary degree of doctor of science was conferred on October 6 by Northwestern University on Dr. Irving S. Cutter, since 1925 until his retirement this year as dean emeritus, dean of the Medical School. Dr. Leslie B. Arey, Robert Laughlin Rea professor of anatomy, presided, and Dr. James Roscoe Miller, the new dean of the Medical School, reviewed his service to the school. A portrait of Dr. Cutter was unveiled.

THE Clement Cleveland Medal, awarded annually for conspicuous service to cancer education, was presented on October 22 at a meeting held at the Advertising Club of New York to Abbott Kimball, president of the Kimball Advertising Agency, at the opening of the campaign to raise funds for the New York City Cancer Committee.

THE James H. McGraw Medal and purse of the National Electrical Manufacturers was presented at a luncheon held at the recent New York meeting to Dwight G. Phelps, vice-president of Colt's Patent Fire Arms Manufacturing Company. The award was made in recognition of his "distinguished contribution to the manufacturing branch of the electrical industry in the surveying of wage experience within the industry to establish a sound basis for company policy and for minimum wage control under the Walsh-Healy law."

SIDNEY DALE KIRKPATRICK, editor of *Chemical and Metallurgical Engineering,* has been elected president of the American Institute of Chemical Engineers for the year 1942. James LeRoy Bennett, manager of chemical operations for the Hercules Powder Company of Wilmington, Del., has been elected vice-president.

THE National Institute of Psychology, at a meeting at Northwestern University, Evanston, Ill., on September 4, elected officers as follows: *President,* Dr. John A. McGeoch, the State University of Iowa; *Vice-president,* Dr. Ernest R. Hilgard, Stanford University; *Secretary-treasurer,* Dr. G. R. Wendt, Wesleyan University; *Directors,* Dr. Walter R. Miles, Yale University, and Dr. L. L. Thurstone, University of Chicago.

THE Society for the Study of Growth and Development at its annual meeting and symposium at Dartmouth College, which was held from July 7 to 11, elected the following officers: *Chairman,* Dr. Paul Weiss, Chicago; *Treasurer,* Dr. J. Walter Wilson, Brown; *Secretary,* Dr. Kenneth V. Thimann, Harvard; *Members of the Executive Committee,* Dr. B. H. Willier, the Johns Hopkins; Dr. E. W. Sinnott, Yale, and Dr. O. L. Sponsler, California. The executive committee is developing plans for a closer relation with the journal *Growth,* and the adoption of *Growth* as the official organ of the society.

THE Virginia Chapter of Sigma Xi on October 22 elected the following officers: *President,* Dr. A. N. Vyssotsky, astronomy; *Vice-president,* Dr. L. B. Snoddy, physics; *Secretary,* Dr. Joseph K. Roberts, geology; *Treasurer,* Dr. Lawrence R. Quarles, engineering.

NEW national officers for the Wasmann Biological Society, to serve for the year 1941–1942, are: *President,* Dr. Harold A. Harper, University of San Francisco; *Vice-president,* the Rev. Charles J. Wideman, S.J., Loyola University, Chicago, and *Secretary-Treasurer,* the Rev. Dominic LaPorte, S.J., Gonzaga University. Other new members of the General Council are: Dr. Carl G. Kadner, Loyola University, Los Angeles, and the Rev. Frank Gubbins, S.J., Gonzaga University. Dr. Edward L. Kessel will continue as managing editor of *The Wasmann Collector.*

JOSEPH W. BARKER, dean of the School of Engineering of Columbia University and chief of the Division of Training Liaison and Coordination of the United States Navy, has been appointed professor of electrical engineering and acting executive officer of the department of electrical engineering. He succeeds Professor Frederick W. Hehre, who died on July 27.

JAMES L. GABBARD, instructor in chemistry at the University of Kentucky, has become professor of chemistry at the Michigan State Normal College, Ypsilanti.

DR. L. D. WOOSTER, for thirty years head of the department of zoology of the Fort Hays Kansas State College at Hays and during the past two years dean of the undergraduate division of the college, has been made president. In a recent note in SCIENCE it was stated incorrectly that Dr. Wooster had become president of "the State Teachers College."

AFTER serving fifteen years at Field Museum of Natural History as assistant curator and curator of physical anthropology, Dr. Henry Field has submitted his resignation. Dr. Field began his services at the museum on October 1, 1926. Since February 16, 1941, he has been associated with the Library of Congress in Washington, D. C., being on leave of absence from the museum.

DR. MARTIN D. YOUNG has been appointed director of the Malaria Research Laboratory, U. S. Public

Health Service, at the South Carolina State Hospital, Columbia, S. C. He succeeds the late Dr. Bruce Mayne.

F. S. BLANCHARD, of Scarsdale, N. Y., president of the United States Institute for Textile Research, has been appointed textile consultant in the Bureau of Industrial Conservation of the Office of Production Management.

FRANK E. MOORE, chairman of the department of poultry husbandry and extension poultryman of the North Dakota Agricultural College, has been appointed poultry coordinator to assist in the administration of the National Poultry Improvement Plan. Mr. Moore, whose appointment was effective on October 24, succeeds J. D. Sykes, who resigned several months ago.

JAMES D. BUMP, instructor in geology and museum curator and technician at the South Dakota School of Mines, Rapid City, has been made director of the museum.

C. N. BALDWIN, director of the Washington Zoological Park at Portland, Ore., formerly in charge of the collection of animals on San Simeon Ranch, owned by William Randolph Hearst, has been appointed director of the San Francisco Zoological Garden.

CHARLES G. BRANNAN has been appointed regional director of the Forest Service Administration, Region Ten, with headquarters at Denver, Colo., to have charge of activities in Montana, Wyoming and Colorado except in the fourteen southeastern counties.

IT is reported in *Industrial Standardization* that E. W. Ely, chief of the Division of Simplified Practice of the National Bureau of Standards, and Robert A. Martino, of the Codes and Specifications, have been released by the Department of Commerce to work with the new Conservation Bureau of the Office of Production Management. The National Bureau of Standards announces that in connection with the new set-up it has changed its procedure to make it possible for the government to initiate simplification projects, either through the Office of Production Management or the Department of Commerce. Hitherto, only non-governmental organizations have had the authority to initiate these projects.

DR. W. R. COE, professor emeritus of zoology at Yale University, has returned to the Scripps Institution of Oceanography, La Jolla, of the University of California, to resume studies of the California mussel made in collaboration with Dr. Denis L. Fox, assistant professor of marine biochemistry.

PHYSICIANS from various parts of the world who have recently visited the Medical School of the University of California include, from Argentina, Dr. Juan Allende, clinical professor of surgery at the Cordoba University; Dr. Felipe Carranza, specialist in malignant disease at the University of Buenos Aires, and Dr. Jose A. Saralegui, of the University of Buenos Aires and director of the Municipal Institute of Radiology and Physiotherapy, and from China, Dr. Chien-liang Hsu, instructor in radiology, and Dr. W. A. Ma, of the department of anatomy of the Peiping Union Medical College.

DR. KARL F. MEYER, professor of bacteriology and director of the Hooper Foundation of the Medical School of the University of California, will give the Craig Lecture at the annual meeting of the American Society of Tropical Medicine in St. Louis on November 10, and on November 14 and 15 he will speak before the Southern California Medical Association.

THE first Edwin R. Kretschmer Memorial Lecture of the Institute of Medicine of Chicago, under a foundation established by Dr. and Mrs. Herman L. Kretschmer in memory of their son, will be delivered on November 11 by Dr. John H. Lawrence, assistant professor of medicine in the University of California Medical School. The title of the lecture is "Studies on Leukemia and Allied Diseases with Artificial Radioactivity."

THE final dates for the Salmon Memorial Lectures which Dr. Robert D. Gillespie, psychiatric specialist of the British Royal Air Force, will deliver in key cities of this country and Canada, have been announced as follows: Toronto, November 19; Chicago, November 21; New Orleans, November 22; Washington, November 24 and 25; San Francisco, November 27; Philadelphia, November 30.

THE thirty-fourth annual meeting of the American Society of Animal Production will be held at the Hotel Sherman, Chicago, on November 28, 29 and 30.

PRESENTATION has been made to the New York Botanical Garden of the herbarium of the late Howard J. Banker, as announced in a biography of Dr. Banker in the July–August issue of *Mycologia*. The gift was made by Mrs. Banker to carry out her husband's request. The herbarium consists of 4,477 specimens, and while the majority represent the lower plants, principally fungi, there are more than 2,000 examples of the higher plants, many of them carefully and artistically mounted.

THE Association of Medical Students is sponsoring a scholarship competition among medical students. The Schering Award of the association offers scholarships to medical students preparing the best dissertations on the history of endocrine research. The scholarships have been donated by the Schering Corporation in order to encourage the current interest

in endocrinological developments by offering talented medical students a chance to pursue an inquiry into the history of endocrine research. Further information can be obtained by addressing the Committee on the Schering Award, Association of Medical Students, 25 Madison Square North, New York, N. Y.

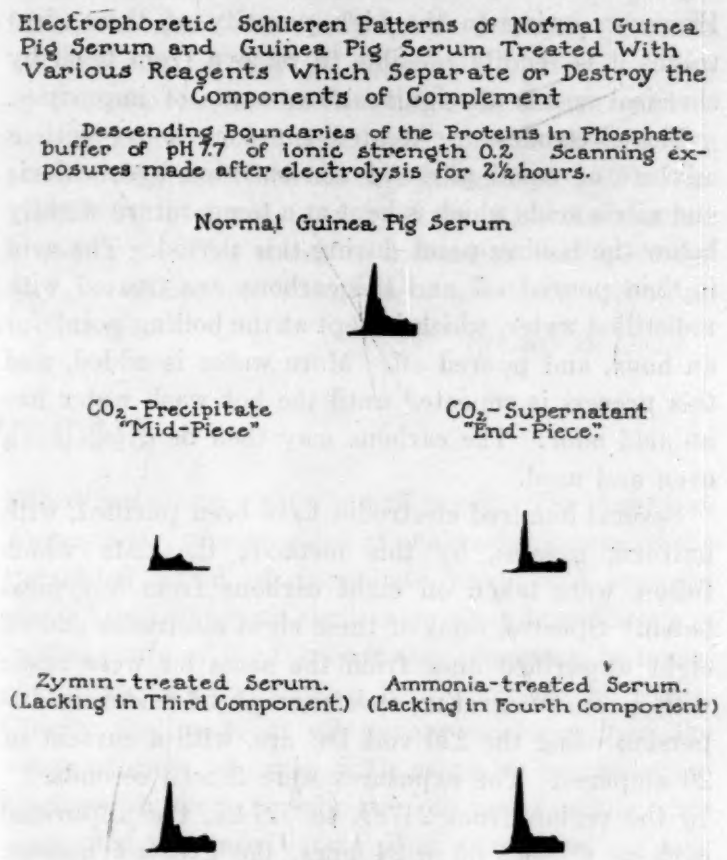
DISCUSSION

THE TERMINOLOGY OF THE COMPONENTS OF COMPLEMENT[1]

IT is well established that hemolytic complement is composed of four functionally distinct components which individually are inactive.[2-8] Treatment of serum with distilled water,[2] carbon dioxide,[9] or dilute hydrochloric acid[10] has been shown to separate complement into two thermolabile components. One globulin fraction has been designated the "mid-piece," and the so-called albumin fraction has been termed the "end-piece." In addition, it has been shown that yeast cells or an insoluble carbohydrate isolated from yeast inactivate a relatively heat-stable component of complement, the "third component."[3,7] It has also been shown that dilute ammonia and amino compounds capable of reacting with carbonyl groups destroy another thermostable fraction, the "fourth component."[4,6]

The two thermolabile components of complement owe their terminology to their action rather than to their nature. The two thermostable fractions were named "third" and "fourth" components after their order of discovery.

During studies on the separation and characterization of the components of complement,[11] electrophoretic diagrams were obtained of mid-piece and end-piece prepared by the carbon dioxide method, as well as of complement deprived of its third component (zymin-treated) and of its fourth component (ammonia-treated). The diagrams are presented in Fig. 1, and indicate that the so-called globulin fraction or mid-piece contains at least four distinct proteins, two of which have mobilities faster than any of those originally present in whole serum; while the end-piece or so-called albumin fraction also contains at least four distinct proteins as judged electrophoretically, one of which appears to be γ-globulin. No significant difference is detected electrophoretically between normal serum and serum deprived of its fourth component. Serum lacking in third component shows a disturbance of the α-globulins.


Normal Guinea Pig Serum
CO_2-Precipitate "Mid-Piece"
CO_2-Supernatant "End-Piece"
Zymin-treated Serum. (Lacking in Third Component)
Ammonia-treated Serum. (Lacking in Fourth Component)

Electrophoretic Schlieren Patterns of Normal Guinea Pig Serum and Guinea Pig Serum Treated With Various Reagents Which Separate or Destroy the Components of Complement

Descending Boundaries of the Proteins in Phosphate buffer of pH 7.7 of ionic strength 0.2 Scanning exposures made after electrolysis for 2½ hours.

FIG. 1

It is evident from these diagrams that the terms "mid-piece," "end-piece," "albumin fraction," "globulin fraction" are misleading and unsatisfactory. Therefore, it is suggested that the four components of complement be designated by the following symbols:

C′1—mid-piece
C′2—end-piece
C′3—third component
C′4—fourth component

The terminology proposed for the complement components was arrived at after discussion and agreement with Dr. Michael Heidelberger.

L. PILLEMER
E. E. ECKER

INSTITUTE OF PATHOLOGY,
WESTERN RESERVE UNIVERSITY AND THE
UNIVERSITY HOSPITALS OF CLEVELAND

[1] Aided by a grant from the Commonwealth Fund.

[2] H. von Buchner, *Arch. f. Hyg., Berlin*, 17: 179, 1893.
[3] E. von Dungern, *München. med. Wchnschr.*, 47: 677, 1900.
[4] J. Gordon, H. R. Whitehead and A. Wormall, *Biochem. Jour.*, 20: 1028, 1036, 1044, 1926.
[5] H. R. Whitehead, J. Gordon and A. Wormall, *Biochem. Jour.*, 19: 618, 1925.
[6] L. Pillemer, J. Seifter and E. E. Ecker, *Jour. Immunol.*, 40: 89, 1941.
[7] L. Pillemer and E. E. Ecker, *Jour. Biol. Chem.*, 137: 139, 1941.
[8] L. Pillemer, J. Seifter and E. E. Ecker, *Jour. Immunol.*, 40: 101, 1941.
[9] H. Liefmann, *München. med. Wchnschr.*, 56: 2097, 1909.
[10] H. Sachs and K. Altmann, cited from Handbuch der Technik und Methodik der Immunitätsforschung, Bd. 2: 969, 1909.
[11] L. Pillemer, E. E. Ecker, J. L. Oncley and E. J. Cohn, *J. Exp. Med.*, 74: 297, 1941.

THE PURIFICATION OF SPECTROGRAPHIC CARBONS[1]

GRAPHITE electrodes purified especially for spectrographic analysis are available at a rather high price; those ordinarily used contain appreciable amounts of impurities in varying numbers and varying quantities. However, owing to the high porosity of these electrodes it is readily possible to remove from them by chemical means all significant amounts of impurities.

The electrodes are treated for four hours with a mixture of equal parts of concentrated hydrochloric and nitric acids which is kept at a temperature slightly below the boiling point during this period. The acid is then poured off and the carbons are treated with redistilled water, which is kept at the boiling point for an hour, and poured off. More water is added, and this process is repeated until the hot wash water has no acid odor. The carbons may then be dried in an oven and used.

Several hundred electrodes have been purified, with uniform success, by this method; the data which follow were taken on eight carbons from a typical batch. Spectrograms of these eight electrodes and of eight unpurified ones from the same lot were made with a concave grating spectrograph of moderate dispersion using the 220 volt DC arc, with a current of 20 amperes. The exposures were fifteen seconds. In the region from 2478Å to 3274Å, the unpurified carbons showed 56 ± 24 lines, the greatest number being 110 and the least, 33. Calcium, magnesium, silicon, copper, iron, titanium and manganese were identified among the impurities.

The purified electrodes showed in the same region only 2 ± 1.7 lines. Of the eight electrodes examined, five showed only the 2882Å silicon line, three showed very faint traces of copper, and one, a trace of magnesium. In the visible, the persistent calcium lines at 3934Å and 3968Å remained, but those from 4240Å to 4318Å were entirely absent.

RICHARD ZIETLOW
PHILIP HAMM
R. C. NELSON

MINNESOTA AGRICULTURAL EXPERIMENT STATION

THE CORRECTION BY SCIENTISTS OF MANUSCRIPTS FOR THE PRESS

As a professional science reporter and interpreter of science for the layman I recently had the pleasurable experience of working with Dr. John A. Wilson, director of the Oriental Institute of the University of Chicago, in the preparation of an article relating to the new discoveries of the Mitannian civilization in the Near East. Following the approved practice, employed by members of such organizations as the National Association of Science Writers, the manuscript was sent to Dr. Wilson for checking, prior to publication, to assure scientific accuracy.

Dr Wilson's prompt but careful treatment of this manuscript and the exceedingly clear manner in which his suggested changes were made—and why they were made—is a splendid example of how scientists can best cooperate in the dissemination of accurate, yet interesting, articles on science in the realm of modern journalism.

As an object lesson to other scientists who may, in the future, be asked by the various science reporters to edit manuscripts for accuracy, the following examples of Dr. Wilson's changes are cited:

Original MS.: "Science now knows that it was the almost mythical and mysterious race known as the Mitanni who introduced the horse and chariot to the Egyptians, the Hittites and other peoples and revolutionized. . . "

Suggested change: "Science now knows that mysterious people known as the Mitanni were important agents in introducing the horse and chariot to the ancient Near East and in revolutionizing. . . . "

Reason: Mitanni were not a biological "race"; term "people" less specific. The Mitanni were one segment of the great Indo-European migration, in which they brought the horse to upper-Mesopotamia, their cousins the Hittites brought it to Anatolia, their cousins the Kassites brought it to lower-Mesopotamia, and a more dilute mixture of Indo-Europeans, the Hyksos, brought it to Egypt.

Another example:

Original MS.: ". . . at a great mound near the headwaters of the Tigris and Euphrates Rivers. . . . "

Suggested change: " . . . at a great mound between the upper Tigris and Euphrates Rivers. . . . "

Reason: The mound of Tell Fakhariyeh is located somewhat like Des Moines in reference to the Mississippi and Missouri Rivers.

Other examples might be cited, but the important thing to note is the pattern which Dr. Wilson uses in his suggested changes. 1. The specific phrase in the original manuscript, which is erroneous or requires a different shade of meaning, is cited. 2. The suggested change is given, keeping as near to the wording of the original as is possible. 3. The reason for the change is given.

Most scientists, when asked to correct a rough manuscript, will obey point No. 1 listed above. Very few of them will follow point 2 in keeping as near to the original phraseology as possible. Still fewer will give the reason for the suggested change.

Point 2 is important because science reporters desire most the correction of errors of fact, or misinterpretation. If they write in the vernacular of the newspapers they do so because this simple language—

[1] Paper No. 1921 of the Scientific Journal Series, Minnesota Agricultural Experiment Station.

rather than technical phraseology—will be read by the newspaper public. Many scientists are unwilling to accept a simple way of saying something and adhere closely to strict scientific terminology.

Point 3 is important because the professional science writers, to-day, are intelligent, specialized and experienced journalists who do nothing except follow and report the latest developments in the world of science. They are willing and eager to correct errors or misinterpretations which may creep into their writings, but they appreciate the courtesy of explanations for the changes in their manuscript. Such explanations are the tribute of equality from the professional man in one field to the professional man in another field of related endeavor. It is only by such mutual respect and cooperation that the great work of advancing the dissemination of knowledge of science to the public can be raised to greater heights.

ROBERT D. POTTER,
Science Editor, The American Weekly

REPRINTS FOR EUROPEAN LABORATORIES

MOST European laboratories are unable at present to obtain American (or British) scientific journals, but can receive reprints, especially if they are sent by first-class mail. In the past week I have received two letters from scientists in Denmark and Sweden complaining that their work was handicapped by unavailability of journals, and thanking me for reprints I had sent. This seems to indicate a very practical way for American scientists to aid their colleagues in Europe.

ROBERT B. DEAN

QUOTATIONS

SCIENCE SHOWS THE WAY

THE significance of the conference on Science and World Order has been two-fold. It has held aloft the torch of free scientific discussion between men of many nations on issues of vital importance to humanity—"the greatest torch," in the words of General Smuts's recorded message to the conference, "that the spirit of man has kindled in the modern world"; and it has emphasized the increasingly close relationship between science and government. The relationship has never been closer than in this war. Not only the fighting services but all other forms of governmental activity are increasingly dependent on science. This dependence has perhaps not yet been as fully realized everywhere as it should have been. There are still gaps due to obstructive traditionalism. Professor Haldane may be right in thinking that the potentially valuable services of men of science less persistent than himself are sometimes left unused; and, among lesser men, there are still too many stories of trained chemists working as orderlies or pay clerks. But in general the change in outlook has been undeniable and striking. It has not been confined to general staffs and civil servants. Men of science on their side have learned to regard themselves not as mere consultants sitting in remote laboratories but as active participants in front-line warfare and in the framing of military and administrative policy. The conference which ended last night has certainly not been "academic" in the invidious sense of the word.

More important in the long run even than relations between science and government are relations between science and the people. Much was said at the conference about planning for the future. But, as one speaker remarked, planning can never be more than an "administrative convenience" until it is brought into direct contact with human needs. The American Ambassador, who presided at one session, spoke of the "wounded world of immediate needs and crowded wants" into which we shall move when hostilities end. In this world of the future it may sometimes be necessary to strike a nice balance between needs and wants. Clearly the needs of all have precedence over the wants of some. In such fields as health and nutrition much can be done by education to make people want most what they need most. But, save where military exigencies in time of war and restricted resources in time of peace are a limiting factor, intelligent planning must make allowance not only for human needs, but for human preferences and even for human caprice. There is nothing scientific about herding together in blocks of flats the people who want their own cottages and backyards.

In fact science, if it is to fulfil its human mission, will have to concern itself in future as much with the consumer as with the producer. This implies to some extent a reversal of past attitudes. But the whole conception of the needs and wants of the consumer as the starting-point of a program of reconstruction owes much to those who in recent years have worked out, especially in the field of nutrition, standards recognized as the necessary minimum for human well-being, and have shown how far existing standards, even in advanced countries, fall below them. The recognition of such standards was rightly described by Herbert Morrison as "a new social and political factor of the first importance." It has aroused the social consciences of all classes, and has established a principle accepted by all parties as an obligation overriding selfish or sectional interests. The war has forced on this country what Sir John Orr urged as a permanent and universal objective—"a food policy

based on nutritional needs." Nor are these considerations confined to problems of nutrition, though this may provide the simplest and most urgent field for their application. The almost equally elementary requirements of housing and clothing will also call after the war for comprehensive policies, the lines of which are already beginning to shape themselves. The same principles might easily be applied to some of the more sophisticated requirements of modern civilization. Mr. Morrison spoke of standards in education and in leisure; and Mrs. Hamilton invited science to bring into the kitchens of the workers those hitherto expensive "appliances and fittings" which would rationalize the burden of housekeeping for all classes and release a store of female capacity and energy at present absorbed by household duties.

Thus the conference did not disdain the domestic view. But its international composition was calculated to ensure that the problems under discussion would be placed in their world setting. Like all great modern problems, the contribution of science to the advancement of human welfare is a world-wide issue. It has been realized for many years that the substantial increase in standards of nutrition, which science has shown to be necessary on grounds of health and efficiency, provides the one prospect of overcoming the chronic crisis of so-called "over-production" which has overtaken every agricultural country in the world in the past twenty years. Sir John Orr quoted some striking figures to illustrate the expansion of agricultural production which would be needed in order to bring the nutrition of the whole population up to standard even in the United States, the richest country in the world; and he went on to argue that a policy of meeting nutritional needs everywhere would rule out any danger of an agricultural slump for many years to come. What is true of the crisis of agriculture is true in a scarcely less marked degree of the crisis of industry. As Sir Harold Hartley suggested in his paper on world heat and power requirements, the economic vicissitudes of the present century may be largely due to the failure of the world to adjust itself to the "closing of the frontier"—the cessation of natural and automatic expansion into virgin territories—which approximately coincided with the end of the nineteenth century. Science continues to increase the world's productive capacity as rapidly under the new conditions as under the old. What it must now teach us to do, by releasing new sources of energy, is to substitute an organized and intensive expansion of consumption for the unorganized and extensive expansion of the previous period.

But, though science shows the way, it would be presumptuous to believe that science alone can lead us to the goal. The men of science themselves have moved far since the era of uncritical optimism, when progress was regarded as automatic and science as its predestined instrument. We need no evidence to-day that science can serve evil ends as well as good. It can be invoked to bolster up narrow sectional interests as easily as to promote the welfare of the community. This is no reproach to the instrument, but a reminder that the ultimate test of its value lies in the moral quality of the human purpose directing it. The most important service rendered by the conference of the past few days has been to bring to public knowledge the almost unlimited potentialities of human development and human well-being which science has to offer. Science provides the opportunity. There must also be the will to use it aright.—*The London Times.*

SCIENTIFIC BOOKS

CHEMISTRY

Laboratory Manual for General College Chemistry. By JOSEPH A. BABOR and ALEXANDER LEHRMAN. 289 pp. + appendices + 10 pp. graph paper. New York: Thomas Y. Crowell Company. 1940.

THIS laboratory manual is designed primarily for those students who have some background for chemistry. Accordingly, emphasis is placed on laboratory technique and on stressing the limitations of quantitative measurements. The numerous problems in the experiments elaborate upon principles and involve numerical calculations to illustrate quantitative relationships. It is interesting to note a detailed description of weighing has been omitted.

The material is presented in the "Work Book" or "Fill In" type of arrangement. An innovation in the manner of printing is the use of two columns per page as employed by the scientific journals. Accordingly, it is not as difficult to read the printed matter as when the single column arrangement is used. It is unfortunate, however, that the amount of space provided for answers is too limited for the usual response that a teacher would expect.

Extensive appendices which include data frequently used in the solution of problems and in the performance of experiments are designed to place the responsibility upon the student for selecting pertinent information for use in a particular problem.

The exercises are especially well planned and given very explicit directions on laboratory technique. Each exercise begins with a discussion of principles and is followed by directions and problems.

An abridged Hubbard "Periodic Chart" is printed

on the back cover and will be very useful both to the teacher and the student. An ample supply of graph paper is furnished for use in the many experiments where data are plotted in order to illustrate the principles involved. The manual is on 8½ × 11 paper and bound with one of the newer type spiral binders.

The laboratory manual for "General College Chemistry" is very adaptable for use in the elementary chemistry laboratory.

L. L. QUILL

Experimental General Chemistry. By J. W. NECKERS, T. W. ABBOTT, K. A. VAN LENTE. 282 pp. New York: Thomas Y. Crowell Company. 1940. $1.75.

SIXTY-ONE carefully selected experiments designed for a year's course in elementary general chemistry have been assembled in this laboratory manual. One distinctive feature of this book is the use of "Preliminary Exercises" which contain leading and pertinent questions about the purpose and the problems of each experiment. Each experiment is preceded by these preliminary exercises which are to be assigned in advance and handed in at the beginning of each laboratory period. These exercises are printed separately from the laboratory exercise with which they are associated. The fact that the student must do a certain amount of work previous to starting the actual laboratory study should facilitate the performance of the experiment as well as making the laboratory work more interesting.

The authors have utilized the term "spatula spoonful" whenever accurate quantities of solid reagents are unnecessary. This innovation is being used widely by teachers of chemistry at the present time. The scheme saves considerable time for experimental work and eliminates the necessity of waiting for a balance. Frequent references to industrial processes are included throughout the book.

The manual is a very practical, well-arranged and teachable book, on 8½ × 11 format. Adequate space in which the students may answer questions and do calculations is allowed. The custom of correlating the laboratory manual with several elementary text-books has been followed by these authors.

L. L. QUILL

Physical Chemistry. By A. E. MOELWYN-HUGHES. viii + 660 pp. Illustrated. New York: The Macmillan Company; London: Cambridge University Press. 1940. $9.50.

THIS book is an ambitious attempt to present a complete development of modern theoretical chemistry in one volume. Actually it is a simplified version of Fowler and Guggenheim's "Statistical Thermodynamics," which any mathematically minded graduate student might follow regardless of his preparation. The first 282 pages takes up the physical foundations—the fundamental constants, elementary quantum mechanics and statistical mechanics. The rest of the book applies these principles to thermodynamics, atomic and molecular spectra, dipole moments, chemical equilibria, kinetics of gas reactions and crystal structure. Every effort has been made to make the mathematics complete, often at the expense of brevity. "All theorems are derived; no proof is taken for granted." A large amount of carefully selected experimental data illustrates the physical principles. No problems to be worked out by the student are given.

The treatment of kinetic molecular theory is excellent, except for the use of the old values of the fundamental constants. The experimental basis of quantum mechanics is very complete. The mathematical derivation of quantum mechanics follows the historical approach and the reader is led through a maze of old Bohr theory which he must unlearn before starting the next chapter. Fifty pages are devoted to elementary wave mechanics, but the treatment does not get beyond the hydrogen atom. Perturbation methods and the nature of chemical bonds are not discussed. The chapter on thermodynamics is concise but not critical. For example, Trouton's rule is stressed but no mention is made of Hildebrand's modification. Intermolecular forces are discussed at some length. Diatomic spectra are stressed but predissociation is not mentioned.

The treatment of equilibria is the best feature of the book. Extensive tables of equilibrium constants, entropy and heat changes, etc., are given together with the original references. Some of the better known equilibria are studied in detail from both the experimental and theoretical angles.

The section on the theory of reaction rates is surprisingly weak. The contributions of Eyring are hardly mentioned. No calculation of an actual reaction rate is made. No mention is made of entropy of activation, and no attempt is made to interpret unusually fast or unusually slow reactions. Although Moelwyn-Hughes is a master of solution chemistry, no reactions in the liquid phase are considered.

A very useful summary of different types of rate equations and their integrated solutions is given in the appendix.

This book is far too advanced for an elementary course and too limited in scope for the usual course in advanced physical chemistry. Moelwyn-Hughes had an excellent goal in trying to systematize physical chemistry, but he placed so much emphasis on physical preliminaries that he did not have sufficient space to consider the chemical problems adequately.

JOSEPH O. HIRSCHFELDER

SPECIAL ARTICLES

PROGRESS REPORT ON POSSIBILITIES IN PROGENY-TEST BREEDING

THE extent to which plants and animals can be gradually modified by selective breeding over a series of generations in some predetermined direction, such as more rapid growth or increased yields—to mention only two examples from a very long list—as contrasted with the preservation of haphazard but inheritable modifications, known as "mutations," is evidently of significance to the theory of evolution by means of natural selection, because if man can change the character of a population by suitable methods of selective breeding to a sufficient extent in some desired direction, it is not unlikely that the same amount of change can be made by natural selection, even if the rate of change is too small to be measured in a human lifetime. Men's views on the effectiveness of artificial selection have passed from belief in its power to produce very extensive, indeed almost unlimited, modification to skepticism so great that twenty years ago biologists practically abandoned active work in this field. This change of opinion arose from lack of success in continuing the modification beyond nearby limits, thus leading to the conclusion that the amount of modification is so restricted that further work along this line would be of little value.

However, new efforts lead to renewed hope that larger changes can be made in quantitative characters than was indicated by the earlier efforts. The renewed efforts are merely a beginning—a very small beginning, it is true. And though it would be very unwise to conclude from what has already been accomplished, that the present rate of progress will be maintained indefinitely, nevertheless, the change already made in velocity of growth processes indicates that we may perhaps accomplish with sufficient time these larger changes which the men who followed Darwin thought could be accomplished by purely phenotypic selection. At any rate, ambitious young men with great capacity for lifetime application to a single task have an opportunity to devote their energies to a field of work which promises abundant returns from their time and attention.

This report deals with an experiment in increasing the body weight of mice, first reported in the *Journal of Heredity* for February, 1938. Using the progeny-test methods there described, it has proceeded from the fourteen chronological groups[1] of that paper through twenty-eight, thus doubling the number of groups during which the average weight of the mice has increased. The average weight of each of the fourteen new groups, added to the fourteen previously reported, is shown in Fig. 1.

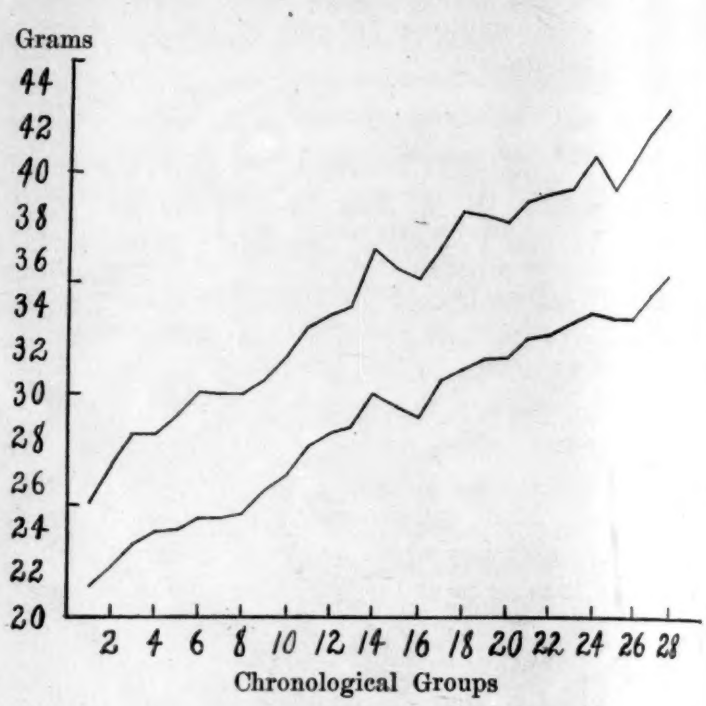


FIG. 1. The upper line shows the average weight of the mice arranged chronologically by groups of five hundred male numbers. The lower line shows female averages, but since females are more numerous than males, each female group, in order to synchronize with the corresponding male group, as a rule contains more than five hundred females. Since counts of the number of generations in the pedigrees of the mice of the last group correspond closely with the number of groups, a group may be taken as a generation, although the first group includes the first four generations and part of the fifth. Chronological groups are used because the number of generations in the ancestry of any individual mouse is not the same in the various possible ancestral lines.

An increase in the weight of the heaviest animals has also occurred. Thus the heaviest male in the last group weighs 54.3 grams as compared to 48.1 of the fourteenth group and 34.2 of the first group. The corresponding females' weights are 49.7, 41.0 and 28.6 grams, respectively (equivalent, on the average ratio of male and female weights, to males of 60.1, 49.6 and 34.6 grams, respectively), these weights being taken at the standard age of two months. Males weighing as much as 35.5 grams at one month of age—the weight of very large, full-grown albino males of the ordinary sort—have been recorded, and aged females have reached 87.5 grams. Thus the heaviest mice

[1] See the description of Fig. 1.

weigh nearly twice as much as the heaviest individuals of most strains of laboratory albino mice.

This experiment was designed in the first place to throw light on the amount of improvement which might be made in the productive qualities of farm animals. When it is realized that the number of parent mice—some 1,200 males and 6,000 females—in the entire twenty-eight generations is very small compared to the hundreds of thousands or even millions of each kind of farm animal mated every year in the United States of America, it would seem that by adding a small amount, perhaps one per cent., to the labor now required to maintain these animals, their productivity can be changed from a level suited to medieval times to a level befitting the twentieth century. If the attained increase in the average weight of the mice is taken as a guide in estimating possible improvement, average milk yield could be increased 70 per cent., horses could be 70 per cent. stronger or speedier, pigs grow 70 per cent. faster, with a corresponding amount of improvement in other animals.[2] We may even wonder what the world would be like if the brain power of the human race were to be increased in like proportion.

Progeny-test breeding of the kind used with the mice may also be applied to plants in numerous ways, such as the development of races adapted to conditions of life to which the parent race is ill adapted, more rapid growth or less rapid growth, indeed to any continuously varying character—not that it will replace other methods of breeding, such as hybridization, which are so effective for some purposes, but that it can be used for purposes to which other methods of breeding are inapplicable, with good prospects of making progress in the desired direction.

The bearing of this work on evolution by means of natural selection is not found in the amount of change, which, after all, is not very large, or in the method of breeding which does not occur in nature in so far as known, but in providing evidence that organisms may be modified at a rate and to an extent that makes further studies along this line worth the necessary time and effort. The means seem to be at hand for accelerating the rate of change which Darwin and his followers supposed occurred in nature at a very slow rate—too slow, indeed, to be observed in short periods of time. Progeny-test breeding, by accelerating the rate of change, offers a means of studying this aspect of evolution experimentally.

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[2] Progeny-test breeding of poultry, under well-controlled conditions, by increasing egg yield by similar amounts, is another demonstration of the possibilities in progeny-test breeding.

ENZYMES IN ONTOGENESIS (ORTHOPTERA). XVII. THE IMPORTANCE OF COPPER FOR PROTYROSINASE[1]

AN inactive tyrosinase or protyrosinase yields a tyrosinase which can be poisoned by carbon monoxide, cyanide and diethyldithiocarbamate. The occurrence of copper in this protyrosinase is thus a reasonable expectation. The purpose of this paper is to test the effects on protyrosinase of the removal and subsequent addition of copper.

Protyrosinase was extracted from eggs of a grasshopper, *Melanoplus differentialis* (Thomas), according to a previously described method.[2] Its tyrosinase activity was measured in a Warburg apparatus. Aerosol, a commercially available synthetic detergent, was added in such excess that any protyrosinase was activated or converted into tyrosinase.

The procedure employed for removing copper from the protyrosinase was similar to that used by Kubowitz in studies of polyphenol oxidase.[3] An excess of potassium cyanide, 5 cc of .01 M KCN, was mixed with 20 cc of the protyrosinase extract. After a half hour 100 cc of saturated ammonium sulfate was added. The precipitate was centrifuged down, washed with 25 cc of saturated ammonium sulfate 0.05 M with respect to potassium cyanide, and dissolved in 0.9 per cent. sodium chloride. This solution was removed to a Cellophane tube and dialyzed against 0.9 per cent. sodium chloride for 50 hours at 0° C. A similar volume of protyrosinase extract received the identical treatment except that sodium chloride was substituted for potassium cyanide. The latter solution served as a control for the extraction of copper. After dialysis the volume of each of the two solutions was brought to 28 cc.

The copper content was estimated by means of a recently described method.[4, 5] A solution of copper sulfate in 0.9 per cent. sodium chloride was used as a source of copper. The total concentration of copper in the Warburg vessels is expressed in terms of moles per liter of reaction fluid (volume equals 3.0 cc).

The results of the treatment with potassium cyanide can be compared in terms of the change in amount of copper. During precipitation and dialysis the control protyrosinase preparation must have lost very little copper, since its 4.7×10^{-6} M represents a 98 per cent. recovery. Only one fifth as much, 0.9×10^{-6} M, remained in the extract treated with cyanide.

[1] Aided by a grant from the Rockefeller Foundation for research in cellular physiology.

[2] T. H. Allen and J. H. Bodine, *Proc. Nat. Acad. Sci.* (in press), 1941.

[3] F. Kubowitz, *Biochem, Zeitschr.*, 299: 32, 1938.

[4] A. Eden and H. H. Green, *Biochem. Jour.*, 34: 1202, 1940.

[5] The analyses were performed by E. B. Newell.

The removal of copper apparently produces a decrease in protyrosinase which can be restored by the addition of a copper salt (Fig. 1). In agreement

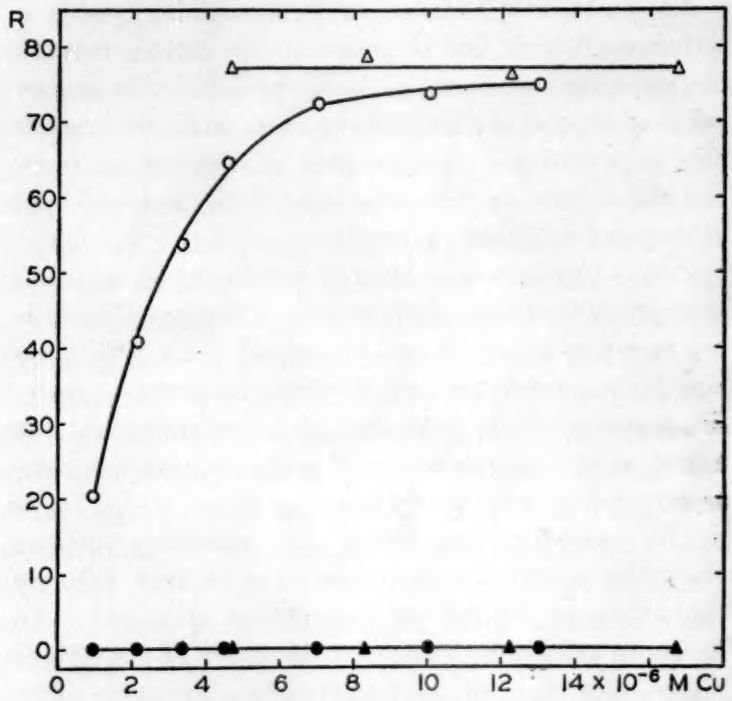

FIG. 1. Resynthesis of protyrosinase. Ordinate, reciprocal $\times 10^3$ of the time in minutes for the initial uptake of 100 c.mm. of oxygen during the oxidation of 6.9×10^{-3} mM of tyramine catalyzed by tyrosinase from 0.3 c.c. of protyrosinase extract. Abscissa, total concentration of copper. Open symbols, 0.07% Aerosol; closed symbols, no Aerosol. Circles, extract from which copper was removed; deltas, extract from which no copper was removed. pH = 6.8; Temp. = 24.9°C.

with Kubowitz[3] it was found that salts of Fe, Co, Ni, Mn and Zn were unable to replace those of Cu. The protyrosinase yields a tyrosinase which seems to be specifically dependent on copper for its enzymic activity. An excess of activator, Aerosol in this instance, seems to be necessary for conversion of protyrosinase into tyrosinase (Fig. 1). It is worthy of note that twice as much copper, that is 10 rather than 5×10^{-6} M, needs to be present for complete restoration of protyrosinase. The resynthesized protyrosinase and tyrosinase are destroyed by heating at 90° for 5 minutes; 18×10^{-6} M copper sulfate and the same with an excess of Aerosol have no catalytic activity. Thus it seems that copper unites with a copper-free substance to give a thermolabile protyrosinase, which in its turn must be activated before a thermolabile tyrosinase is produced. An anomalous and differential heat effect has also been found for protyrosinase extracts of low copper content. *i.e.*, heat treatment between temperatures of 60° and 70° not only inhibited but also activated.[6] The heat effects, therefore, appear to be independent of the copper.

Although the potentially active group of protyrosinase reacts with cyanide, it is unable to activate the enzymic oxidation of substrates. With the present knowledge of protyrosinase it seems hazardous to choose between whether the activation of protyrosinase is primary and direct or secondary and perhaps concerned with the removal of some material surrounding a core of tyrosinase. If the latter were so, it may be pointed out that the shell must be permeable to cyanide and its copper compound yet impermeable to substrates. This kind of semi-permeability would seem to be of a very peculiar order. Since Kubowitz[3] has shown that the active group of polyphenol oxidase indulges in electron exchange in order to catalyze the substrate's oxidation, it is suggested that a difference between protyrosinase and tyrosinase may be concerned with the state of its copper. An activator presumably overcomes some hindrance to oxidation and reduction of the active group.

When its copper is partially removed, a protyrosinase extract yields less tyrosinase. The return of copper leads to resynthesis of protyrosinase. The copper of protyrosinase seems to be a potentially active, prosthetic group.

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J. H. BODINE

STATE UNIVERSITY OF IOWA

[6] J. H. Bodine and T. H. Allen, *Jour. Cell. and Comp. Physiol.*, 12: 71, 1938.

THE USE OF FATTY ACIDS IN INSECTICIDAL AEROSOLS

IN recent investigations[1] it has been shown that some relatively nonvolatile compounds show promise as fumigants against insects when applied in smoke or fog form. This development makes possible the use of safe and inexpensive insecticides that were formerly considered impractical because of difficulties in producing effective concentrations at room temperatures.

In practice a solution of the insecticidal material was sprayed on a heated surface. On coming in contact with the hot surface, the solvent was evaporated with explosive violence, and any dissolved material that did not vaporize readily was reduced mechanically to colloidal dimensions. That is, the insecticide was dispersed as an aerosol consisting of a suspension of the solid or liquid particles in air. By this method of volatilizing it was possible to keep the insecticide dispersed in an enclosed space for a long time. The rate of evaporation was also greatly increased, and the maximum vapor concentration was quickly obtained because of the tremendous surface of these

[1] W. N. Sullivan, L. D. Goodhue and J. H. Fales, *Soap*, 16 (6): 121, 123, 125, illus. 1940.

small particles. The potency was further increased by the direct contact action of these small particles.

The apparatus used in this work consisted of a small nasal type atomizer mounted four inches above the center of an electric hotplate held at 375° C. A small electric compressor was used to maintain the air pressure that operated the atomizer.

To stabilize and increase the toxicity of these insecticidal aerosols, fatty acids (lauric or oleic) were added to the spray solution. It was shown with biological tests against the housefly that these materials increased the effectiveness of orthodichlorobenzene. The results of these tests are given in Table 1.

Although lauric and oleic acids are substantially inert when used alone, under the conditions of these tests they act as adjuvants when combined with orthodichlorobenzene and greatly increase the effectiveness of the aerosol. Certain fatty acid derivatives, such as salts, esters, and the like, also gave increased insecticidal action. The results were corroborated by room tests against the roach and the bedbug, where a 100 per cent. mortality was obtained by using 1.5 pounds of orthodichlorobenzene containing 5 per cent. of lauric acid per 1,000 cubic feet.

TABLE 1

RELATIVE EFFECTIVENESS AGAINST HOUSEFLIES OF ORTHODICHLOROBENZENE, ALONE AND IN COMBINATION WITH OLEIC AND LAURIC ACID, WHEN DISPERSED IN AEROSOL FORM; EXPOSURE PERIOD 30 MINUTES*

Material tested	Number of insects tested	Mortality after 2 days, per cent.
Orthodichlorobenzene	609	2
Orthodichlorobenzene plus oleic acid	440	55
Orthodichlorobenzene plus lauric acid	471	60
Lauric acid	216	1
Oleic acid	220	1

* Orthodichlorobenzene was used at the rate of 0.28 cc per cubic foot and the fatty acid at 0.071 gram per cubic foot.

This method of producing an aerocolloidal dispersion by spraying liquid toxins on a heated surface might be of use to bacteriologists, who have found bacteriocidal aerosols effective in decontaminating rooms.[2]

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A BUBBLER PUMP METHOD FOR QUANTITATIVE ESTIMATIONS OF BACTERIA IN THE AIR[1]

THE bacterial content of the air of a rheumatic fever hospital has been studied regularly throughout the past winter. For quantitative estimations, an air centrifuge of the type described by Wells[2] was used and occasional runs were made with apparatus similar to that of Hollaender and Dalla Valle.[3] Results were so variable even in successive runs in an apparently stable environment that more refined methods of estimating the number of bacteria in air were sought. The most satisfactory machine in respect to efficiency and ease of operation was a modification of that described by Robertson,[4] Bigg, Miller and Baker in SCIENCE, February 28, 1941. This operated on the principle of the slow bubbling of air through liquid media. Glass beads serve to break up bubbles and release bacteria to the broth which might otherwise escape within the bubbles.

The apparatus shown in Fig. 1 consists of a sterile 250 cc Erlenmeyer suction flask containing a measured quantity of glass beads and broth. Air is drawn through this flask at rates indicated by a U tube manometer at the inlet. At the completion of the ten-minute run, one and two cc amounts of the broth are pipetted to sterile petri dishes and blood agar is poured and mixed with the inoculum. A vacuum

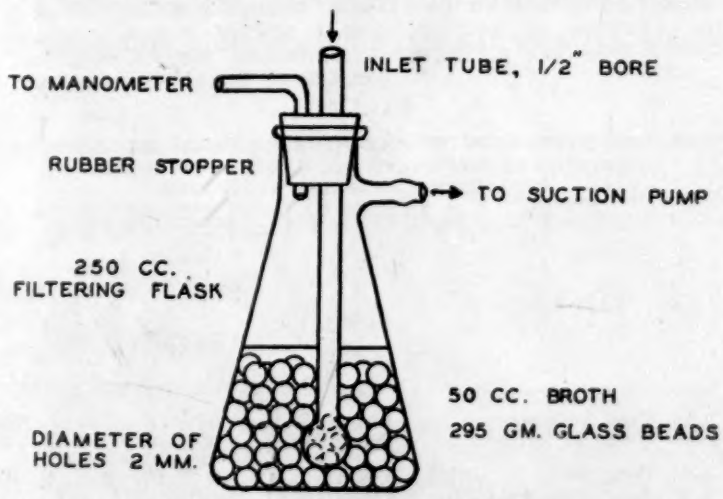

FIG. 1. Diagrammatic drawing of bubbler pump apparatus.

[1] From the Department of Preventive Medicine, Harvard Medical School, and House of the Good Samaritan, Boston, Massachusetts. This work was supported in part by a grant to the House of the Good Samaritan from the Commonwealth Fund.

[2] W. F. Wells, *Am. Jour. Pub. Health*, 23: 58, 1933.

[3] A. Hollaender and J. M. Dalla Valle, *Pub. Health Rep.*, 54: 574, 1939.

[2] C. C. Twort, A. H. Baker, S. R. Finn and E. O. Powell, *Jour. Hygiene*, 40 (3): 253–344, illus. 1940.

[4] O. H. Robertson, E. Bigg, B. F. Miller and Z. Baker, SCIENCE, 93: 213 and 214, 1941.

cleaner motor provided sufficient suction for our purposes. Inlet tubes were specially constructed with one-half inch bore and with the submerged end a perforated bulb of the bubbler type to prevent clogging or unequal pressure from the glass beads.

Calibration of the air flow was determined by the displacement of air by water in a two-liter flask and checking these rates with differences in the manometer levels. Best results were obtained at relatively low rates indicated by the gentle bubbling of air through the broth and beads. Optimum speeds were between 3.6 and 9.0 liters per minute. Too strong suction tended to cause splashing and sucking of broth through the outlet of the flask. As in bacterial analysis of milk, the number of colonies found in plates poured with one and two cc samples of broth are multiplied to the number which should be present in the entire 50 cc. Immediate pour plates of the broth are not necessary since significant bacterial growth does not take place for an hour or more even at room temperature. However, if immediate pouring is not practical it is advisable to store the flasks in the refrigerator. Colony counts of samples ranging from 0.5 cc to 3 cc reveal a straight line relationship of size of sample to number of colonies.

Tests on the efficiency of this machine by attaching it in series to the Wells Air Centrifuge, and tests where two of the bubbler pumps are set up so that the exhaust of one is attached to the inlet of the other reveal that bacteria of air samples are more thoroughly absorbed by the bubbler pump than the air centrifuge. Table 1 shows the magnitude of this difference in

TABLE 1

RELATIVE EFFICIENCY OF THE BUBBLER PUMP AND AIR CENTRIFUGE AS SHOWN BY AIR SAMPLES FROM THE APPARATUS CONNECTED IN SERIES

Apparatus	Unit	Colony counts: 1 ml.	Colony counts: 2 ml.	Estimated colonies av. in 50 ml.	Count in 10 cu. ft.
(A) Two bubbler pump units in series.	Pump No. 1	5	8	225	990
	Pump No. 2	0	0	0	0
(B) Centrifuge in series to the outlet of the bubbler pump.	Pump	6	10	262	1,190
	Centrifuge	–	–	–	1

The above experiments were conducted in the same room on the same day.

colony counts when the machines are arranged in series. When separate runs are made in the same room by the two machines colony counts indicated by the bubbler pump are usually several times that found in an equivalent sample of air from the centrifuge. Table 2 shows sample protocols of such runs.

Preliminary experiments indicate that accurate evaluations of the bacterial content of air under the

TABLE 2

COMPARISON OF BACTERIAL COLONY COUNTS IN AIR SAMPLES: PARALLEL RUNS IN AIR CENTRIFUGE AND BUBBLER PUMP

Room	Color counts: 1 ml.	Color counts: 2 ml.	Av. colony count for 50 ml. broth	Estimated colonies: 10 cu. ft. bubbler pump	Air centrifuge: Colonies counted in 10 cu. ft.
Ward F ...	3	7	162	710	86
Ward E ...	6	14	318	1400	108
Ward H ...	3	5	137	610	58
Room 63 ..	3	5	137	610	170

natural conditions of a hospital ward are possible with these bubbler pumps. Experiments are in progress involving the correlation of dust and bacteria counts and the effect of ultra-violet rays on the bacteria of irradiated rooms.

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COIN MATS FOR THE MICROSCOPIST

THE scarcity of supplies and the increase in cost of cover glasses suggest greater care in preserving those already on hand. It has been learned that much breakage can be avoided by the use of a rubber coin mat. Cover glasses and slides placed on these mats are easily grasped by the fingers without the necessity of pushing them to the edge of the table, where they frequently break from pressure in trying to pick them up, or fall to the floor. There is also a great saving on the finger nails and no risk of undernail splinters from rough tables. As a matter of fact, finger nails, long or short, cease to be a factor in handling the cover glasses. Ease in mounting specimens is sufficient reason for using the coin mat and the saving in breakage will soon amortize any expense involved.

The coin mats may be obtained from the Sun Rubber Company, Barberton, Ohio. Used whole, halved or quartered, they furnish a simple convenience to frustrate an ever-present source of impatience.

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BOOKS RECEIVED

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MEYER, BERNARD S. and DONALD B. ANDERSON. *Laboratory Plant Physiology.* Second edition, revised. Illustrated. Van Nostrand. $2.00.

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